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on

A SUPERCONDUCTING BOLOMETER

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submitted by

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Chief Investigator

1 June 1965

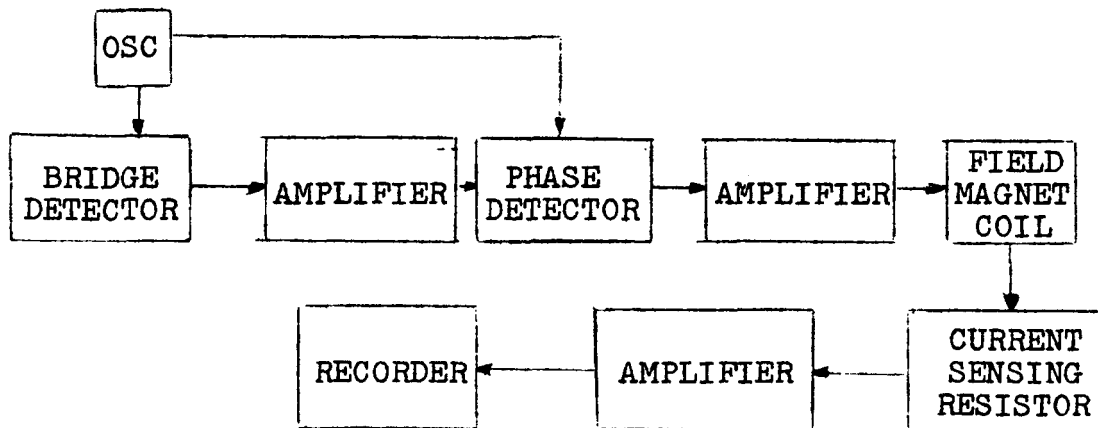
SUPERCONDUCTING BOLOMETER

The bolometer system and its present status are reviewed in the following discussion.

The superconducting bolometer can be operated in several modes, the choice depending to a large extent on the magnitude of the light flux being measured. For weak fluxes it is necessary to operate in the latent heat region of the superconducting sensor. The present bolometer is designed to function in this region. During operation the temperature of the superconducting element is reduced below T_c , its critical temperature. An imposed magnetic field is then adjusted to yield a pre-determined permeability for the sensitive element. This is possible since the magnetic properties yield a non-linear relationship between the magnetic induction B and the imposed field H , the ratio of which determines the permeability. The permeability of the superconducting element is sensed by measuring the self inductance of a small coil adjacent to it.

As light flux falls on the superconductor, the absorbed energy increases its permeability and thereby the self inductance of the sensing coil. The light flux measurement is then obtained by measuring the change necessary in the imposed field to restore the permeability to its original value. The following functional diagram

describes the operation of the electronics.



Fabrication of mechanical parts of the bolometer apparatus is nearly complete. The details of the mechanical apparatus are best explained through reference to the numbered elements in Fig. 1, a cross sectional view of the system.

Port (1) is connected to a pumping system to obtain a vacuum of the order of 10^{-6} mm Hg prior to filling the liquid N_2 reservoir. This vacuum is maintained in regions (2) (3) and (4), thereby minimizing conductive heat losses. Radiation losses are reduced by the low temperature at the N_2 dewar (14).

There are a series of nylon suspension screws (5) around the edge of the nitrogen container (14), minimizing any conductive heat leak from the outside walls of the bolometer. Suspended within the liquid nitrogen container is the liquid helium dewar (9) made of stainless steel, sitting on a nylon ring (6), again minimizing heat leak from nitrogen temperatures. In this container is a copper bar (8), on the front of which the superconducting sample (7)

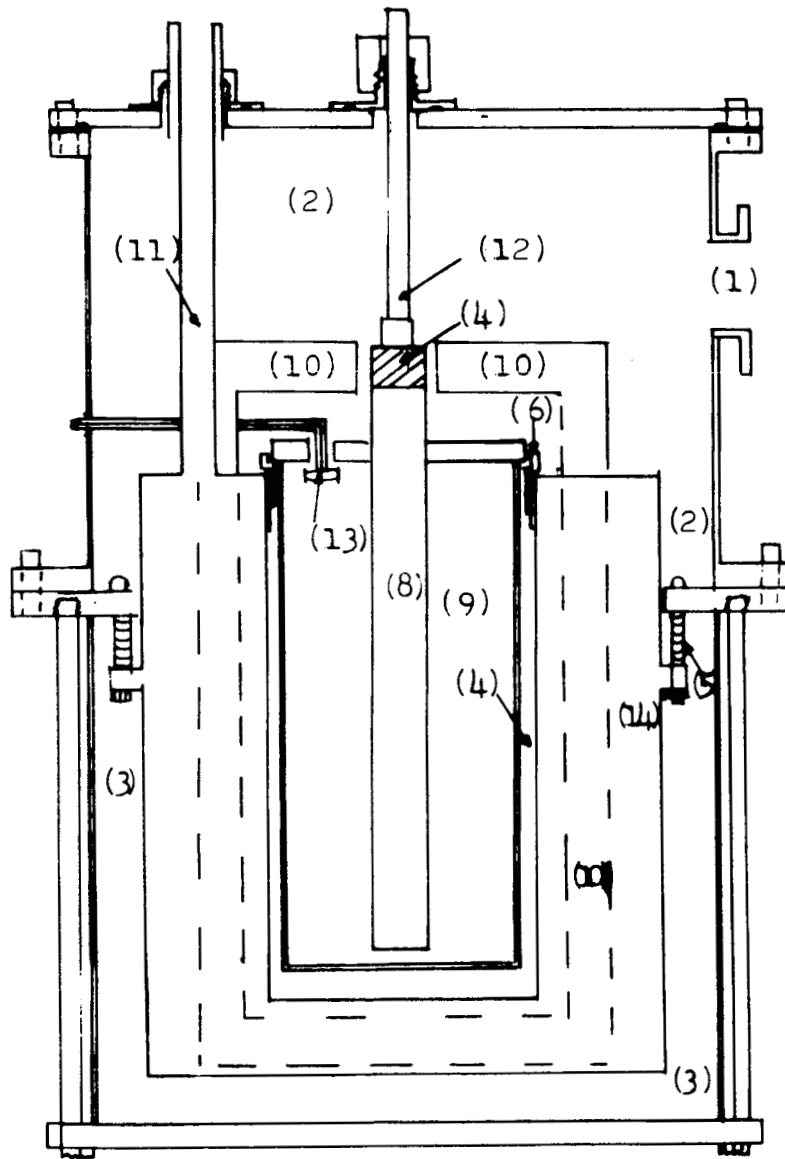


Fig. 1. Cutaway of Bolometer Apparatus

is placed. The magnetic circuit (10) extends from both sides of the sample through the nitrogen chamber. In the top of the helium container is a ceramic feedthrough holding a carbon resistor for level detection purposes (13).*

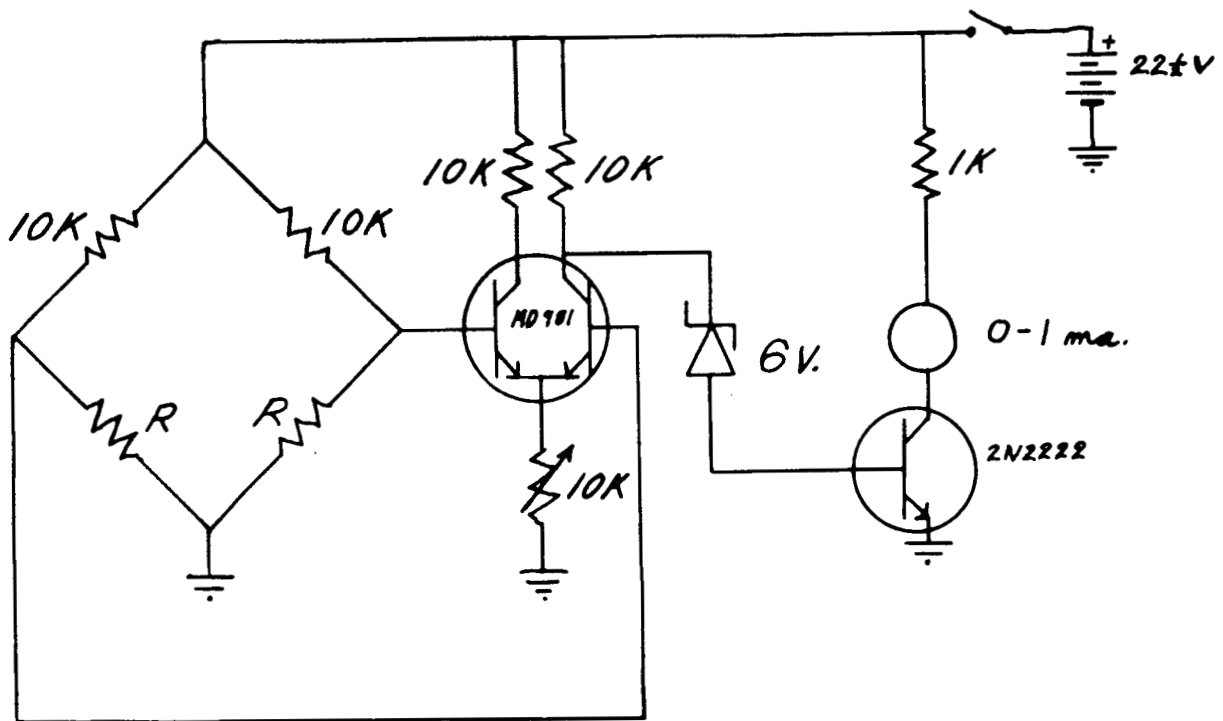
(11) is a thin walled stainless steel nitrogen transfer tube. Tube (12), connecting the helium container to its own pressure control system, is made of thin wall nylon. Helium transfer is through this tube and a hole in the copper bar into the helium dewar.

Not shown is a silvered radiation shield which will be at nitrogen temperatures, shielding the sample from room temperature radiation of the surrounding walls.

The mechanical apparatus requirements consist of only minor plumbing details. The electrical circuitry outlined previously in block diagram is presently being fabricated. All items requiring long lead time have been received and no delays in our program are anticipated.

*The geometry of the system made it necessary to build into the helium dewar a means for monitoring the liquid level. A simple, reliable and inexpensive level sensor has been built using two carbon resistors, one in each arm of a bridge circuit, located one above the other. As the first resistor penetrates the liquid, the bridge becomes unbalanced, causing either a meter deflection or a bulb to light. Details of the circuit are included in Appendix I.

APPENDIX I



Helium Level Detector Circuit

Note: R is 1K sensing resistor

25 copies respectfully submitted,

A handwritten signature in dark ink, appearing to read "G. L. Weissler". The signature is written in a cursive style with a prominent initial "G" and a long, sweeping underline.

G. L. Weissler
Chief Investigator
Contract: NGR-05-018

1 June 1965